AMENDMENTS TO THE SPECIFICATION

Please replace the paragraph beginning at page 1, line 8 with the following new paragraph:

In a solid image sensing apparatus for the purpose of high-speed image sensing, the most critical factor deciding a image sensing speed is a time required to transfer image information generated at a photoelectric transferring apparatus such as a photodiode to a recording apparatus. Thus, most ~~of~~ high-speed video cameras including cameras invented by the present inventor employ ~~employs~~ a method of accelerating the speed of transferring image information from an image sensor to a recording apparatus by concurrently reading out the information using many read-out lines (e.g., see "4500 Frames/se. High-Speed Video Camera", by Takeharu ETOH, published at pp.543-545 of Vol.46, No.5 (1992) of Journal of Television Society).

Please replace the paragraph beginning at page 1, line 21 with the following new paragraph:

There is provided such a method for minimizing the time for transferring information to the recording apparatus that the recording apparatuses are disposed adjacent each of ~~all~~ the photodiodes provided on the light receptive area of the image sensor, without reading out image information from the image sensor. In this case,

the image information is transferred ~~at once~~ from all of the photodiodes at once to the recording apparatus, so that the information transfer is performed concurrently by a total number (usually, a few 10,000 to a few 1,000,000) of these photodiodes provided on the light receptive area. Therefore, a transfer speed at which image information is transferred from each photodiode to the adjacent recording apparatus provides an image sensing speed for each frame of an image. Further, its reciprocal number provides the number of frames per second (frame rate). The present inventor calls such a pixel peripheral recording type image sensor an ISIS (In-Situ Storage Image Sensor). With the ISIS, continuous image sensing is possible at an image sensing speed of equal to or more than 100 million frames/sec.

Please replace the paragraph beginning at page 4, line 3 with the following new paragraph:

The present inventors have ~~has already~~ provided a ~~the~~ MOS type image sensor (see "Ultrahigh-speed multi-framing camera with an automatic trigger, Ultrahigh- and High-speed Photography and Photonics" by T. Etoh and K. Takehara, SPIE vol. 1757, pp. 53-59, 1992).

Please replace the paragraph beginning at page 4, line 8 with the following new paragraph:

Although the MOS type sensor has been regarded as being ~~to be~~ inferior to the CCD type in noise level, a recently available MOS type sensor can obtain an improved ~~in its~~ SN ratio by incorporating an about 30-magnification ~~30-manification~~ amplifier into each pixel ~~is commercially available recently~~. This MOS type sensor is called a CMOS-APS (Active Pixel Sensor).

Please replace the paragraph beginning at page 5, line 1 with the following new paragraph:

In the case of a MOS type image sensor, the larger the capacitance of a read-out line, the larger would be the random noise. However, in the case of a pixel peripheral recording type sensor having a few to a few tens of microns of its image information transfer distance, the random noise can be reduced to 1/1000 through 1/100 as compared to the case with a typical sensor of reading out the image information outside the light receptive area. Also, the cross-sectional area of a metal wire for use in information transfer can be substantially reduced ~~extremely~~ by micro-machining. In this case, the random error may be smaller at the time of information transfer to a recording element in the periphery of pixels and an amplifier may be used for reading out a signal after completion of image sensing.

Please replace the paragraph beginning at page 5, line 15 with the following new paragraph:

Time-wise invariable fixed-pattern noise (FPN) constitutes one problem in the MOS type image sensors. In particular~~particularly~~, a CMOS-APS has such FPN due to irregularities in performance of the amplifier in each pixel. However, the FPN is not much of a ~~hardly cause any~~ problem in science and technological measurement. Namely, since it generally employs digital image processing after image sensing, the FPN can be canceled at the digital image processing.

Please replace the paragraph beginning at page 5, line 23 with the following new paragraph:

In view of the above, it is highly possible to manufacture a CMOS type pixel peripheral recording type image sensor with current ~~the present level of~~ technologies.

Please replace the paragraph beginning at page 7, line 3 with the following new paragraph:

One more operation of this vertical transfer permits five image signals stored in the lowest line of the five parallel vertical CCD transfer paths 6 to be ~~are~~ shifted to a horizontal CCD transfer path 5b in pixels directly below. At the next step of transferring the charges from the photodiode 1 to the horizontal CCD transfer path 5, the

image signals shifted from the upper pixel 4 to the horizontal CCD 5b are consecutively transported rightward and disposed into a drain 7 provided at the left top corner for each pixel in the figure (in this case, a drain 7c in the right bottom corner pixel 4) and then discharged out of the image sensor. Accordingly, 30 frames of the most recent image information are overwritten continuously.

Please replace the paragraph beginning at page 8, line 4 with the following new paragraph:

In the image sensor shown in Fig. 23, however, there is a problem that the perpendicular change in charge transfer direction ~~perpendicularly~~ changes rapidly between horizontal and vertical directions in an alternating manner. Namely, when the perpendicular change in charge transfer direction takes place rapidly ~~perpendicularly changes very fast~~, incomplete transfer (residual charge) cannot be avoided, thus resulting in a deteriorated image quality. Also, an electrode layout at a portion where the transfer direction changes is ~~becomes~~ complicated, resulting in noise occurrence. Further, the complicated electrode layout causes an increase in a size of each element on the CCD transfer path, so that the recording capacity (number of continuous image frames) is decreased unless the size of the pixel 4 is increased. If the pixel 4 is increased in size, on the other

hand, the total number of the pixels for the same light receiving area is decreased, thus deteriorating the resolution.

Please replace the paragraph beginning at page 9, line 20 with the following new paragraph:

In this image sensor, however, its pixel layout is not square but shifts a little rightward. Since science and technological measurement involves a variety of digital image processing on captured images after image sensing, it is easy to convert a non-square layout into a square layout. However, since a ~~the~~ smaller ~~the~~ number of steps for image processing ~~the less~~ would produce less deterioration in ~~the~~ image quality ~~deteriorate~~, it is preferable that the ~~square~~ pixel layout be square ~~is preferable if possible~~.

Please replace the paragraph beginning at page 10, line 3 with the following new paragraph:

Since the pixel peripheral recording type image sensor incorporates many recording elements in each pixel, the pixel size is a few times that with a ~~general~~ usual image sensor, thus resulting in an extremely large sized light receiving area even with a device having a minimum required number of pixels for reproduction of images (about 256 × 256 pixels). This image sensor, which is generally called a large format sensor, has a small yield.

Please replace the paragraph beginning at page 10, line 11 with the following new paragraph:

For example, the above-mentioned image sensor shown in Fig. 24 has, for each pixel, eight vertical CCD elements and six parallel horizontal CCD transfer paths 10. Therefore, in order to achieve a resolution of 256 × 256 pixels with this image sensor, about three million CCD elements (i.e., (256 × 8) × (256 × 6) = 2048 × 1536) are required. Even with ~~the~~ current technology~~level of technologies~~, it is difficult to make a CCD type image sensor having three million elements without ~~no~~ defect.

Please replace the paragraph beginning at page 10, line 20 with the following new paragraph:

The CCD type image sensor generally has very small noise when charges are transferred. A defect in a CCD transfer path inhibits information stored in the pixels upstream side to the defect from being read out, thus resulting in a line-shaped defect and a large decrease in yield. In the CCD type image sensor, therefore, yield provides a largest problem in commercially producing the large format sensors. The MOS type image sensor, on the other hand, has larger noise in reading out information from a read-out line but manufacturing technology thereof is ~~more~~ easier than that of the CCD type image sensor. Also,

its defects appear as a dot-shaped defect per pixel. Such dot-shaped defect can be compensated by interpolation using image information obtained from pixels surrounding the pixel of dot-shaped defect.

Please replace the paragraph beginning at page 11, line 24 with the following new paragraph:

In the case that continuous image sensing at a rate of one million frames/sec. is performed, it is necessary only to give intermittent illumination of 30 times per second and having duration time of 1/1,000,000 with a stroboscope which has a peak light intensity equal thereto when image sensing. Further, by executing image sensing and transfer of the image information obtained thereby 30 times per second in synchronization with the intermittent illumination, motion images can be reproduce with a monitor display. This motion image is as smooth as a general television image, thus enabling trouble-free setting of the image sensing conditions ~~in trouble-free~~. Further, in this case, a total time including a total illumination in setting of image sensing condition and operation time of the image sensor is drastically reduced to 30/1,000,000 of that for continuous image sensing. Thus, even if one hour (3,600 seconds) is required for setting of the image sensing conditions, a total illumination time is only 3,600 × 30/1,000,000 second, i.e. 0.1 second.

Please replace the paragraph beginning at page 12, line 17 with the following new paragraph:

In a CCD type image sensor, in order to reproduce an image, the image information stored in the CCD elements including unnecessary information must ~~once be~~ consequently be read out of the image sensor once. The large format sensor requires high-speed transfer to read out all the image information therefrom, thus causing heating. Therefore, to perform intermittent image sensing at the time of setting the image setting condition with the pixel peripheral recording type image sensor using CCD transfer paths as its recording means, the image information needs to be read out of the image sensor rapidly.

Please replace the paragraph beginning at page 13, line 3 with the following new paragraph:

In ~~the~~ science and technological measurement, image measurement involves ~~is also important by~~ use of, in addition to visible light, ultraviolet ray, infrared ray, X-ray, gamma ray and other electromagnetic waves, electron stream, neutron stream, ion stream, and other particle streams.

Please replace the paragraph beginning at page 14, line 3 with the following new paragraph:

The image sensor according to the present invention, even if a defect exists within a section of the electric-signal recording means, is capable of directly reading out of the light receptive area electric signals generated at a pixel present above that defect, so that defects in a reproduced image caused by that defect can be limited to those dot-shaped ones. The dot-shaped defects can be corrected using the image information of the surrounding pixels. This leads to improvements in production ~~cause drastic improves of the~~ yield.

Please replace the paragraph beginning at page 14, line 13 with the following new paragraph:

Preferably, such a recording means is provided that is directly connected from each of the signal converting means to the read-out line without passing through the electric-signal recording means.

Please replace the paragraph beginning at page 18, line 22 with the following new paragraph:

BRIEF DESCRIPTION OF THE DRAWINGS ~~BREIF DESCRIPTION OF THE DRAWINGNGS~~

Please replace the paragraph beginning at page 23, line 16 with the following new paragraph:

The CCD transfer path 33a extends straightly and obliquely downward as long as six pixels until its bottom end, where it has a drain gate 35a and a drain 36a. The image information, after being transferred in the CCD transfer path 33a, is discharged out of the image sensor through the drain 36a. As described later, the drain gate 35a acts also as a read-out gate. It should be noted that the drain gate 35 is supplied with an operating voltage from a metal wire 56 ~~57~~ shown in Fig. 4.

Please replace the paragraph beginning at page 26, line 16 with the following new paragraph:

It is possible to permit the center line of the CCD transfer path 33a and the line connecting the input gates 32a and 32b to extend in parallel to each other upward and downward directions respectively in the figure. In this case, the CCD transfer path 33b corresponding to the lower side pixel is provided on the left side of the lowering CCD transfer path 33a and charges from the lower side photodiode 30b are sent across the CCD transfer path 33a. This connection is not capable of complete transfer of charge if it is given by any principle other than the CCD principle, e.g. simple metal wires. For straddling with the CCD principle, in the element to be straddled, the charges should be alternately transferred in two directions like in the case of the above-mentioned image sensor shown in Fig. 23. Namely, the image

information is transferred horizontally for straddling, and vertically for sending downward. With the present level of technologytechnologies, it is difficult to alternately transfer the information in two directions at a high speed.

Please replace the paragraph beginning at page 28, line 9 with the following new paragraph:

When a desired phenomenon to be image sensed occursis occurred, the continuous overwriting operation is stopped so that image information held in the CCE transfer path 33 is then read out. The means for this read-out operation will be described below.

Please replace the paragraph beginning at page 28, line 14 with the following new paragraph:

In a state where the CCD transfer path 33 has stopped its transfer operations, one pixel (e.g., a pixel including the photodiode 30a) is selected of all the pixels and the drain gate 35a at the lower end of the CCD transfer path 33a is opened, to perform only one step of the transfer operation by the CCD transfer path 33. By this transfer operation, the first piece of the image information of the 60 pieces of the image information generated at the photodiode 30a is discharged from the drain gate 35a to the drain 36a and then to one of horizontal branched lines 58a of a drain 58 (see Figs. 3 and 6) a drain line 58a

~~(see Fig. 3)~~. All ~~the~~ drain lines 58 are connected to one line, thus being all connected to a read-out circuit outside the light receptive area in read-out operations. Through this read-out circuit, the image information is read out of the image sensor. Namely, the read-out line for the light receptive area and the drain line are shared in use. In addition~~Also~~, the drain gate also acts ~~also~~ as the read-out gate.

Please replace the paragraph beginning at page 30, line 8 with the following new paragraph:

In the present embodiment, a defect on the CCD transfer path 33 has an influence only on a pixel including one photodiode 30_1 the image information of which is recorded by such a CCD transfer path 33, ~~it~~ resulting in a dot-shaped defect on a reproduced image. This dot-shaped defect can be corrected, thus largely improving the manufacturing yield.

Please replace the paragraph beginning at page 30, line 18 with the following new paragraph:

Between the drain 36 and the charge collecting well 31 is provided an overflow gate 48, which is supplied with an operating voltage from the metal wire 57 shown in Fig. 4. If excess charge is generated due to a strong incident light during image sensing, the

excessive charges are discharged via the overflow gate 48 to the drain 36 for preventing occurrence of blooming. During read-out operations, the overflow gate 48 is completely closed. The overflow gate 48 also acts ~~also~~ as a reset gate.

Please replace the paragraph beginning at page 31, line 3 with the following new paragraph:

When setting the image sensing conditions, the overflow gate 48 is used as a read-out MOS gate. This enables direct reading out of image information, without passing ~~makes able to directly read out the image information not~~ through the CCD transfer path 33. During this direct read-out, the drain gate 35 is closed. For example, if an overflow gate 48a of the photodiode 30a is opened in Fig. 2, charges collected in the charge collecting well 31a are moved to the rightward drain 36 and read out of the light receptive area.

Please replace the paragraph beginning at page 35, line 4 with the following new paragraph:

Fig. 10 shows a pixel layout in a high-speed image sensor according to a third embodiment of the present invention. As can be seen from Fig. 10, the present embodiment can be ~~may seem to have been~~ obtained by changing the layout of the pixels of the image sensor provided with the CCD transfer path having a moderate curve shown

in Figs. 24 and 25 into a square layout. Also, it can be ~~may seem to have been~~ obtained by changing the acute-angle corner in the second embodiment shown in Fig. 9 into a moderate-curve corner.

Please replace the paragraph beginning at page 35, line 13 with the following new paragraph:

The four image sensors obtained by inverting and rotating the image sensors shown in Fig. 10 can be butted ~~but~~ along vertical and horizontal center lines 83 and 84 as shown in Fig. 11. Such a construction makes it possible, in addition to the advantage of the above-mentioned square layout of the pixels, to cut and butt ~~but~~ the image sensor into 1/4 with the center lines 83 and 84 as mentioned later. It should be noted that the CCD element pitch is 4.8 × 4.8 microns and the number of pixels is 256 × 256.

Please replace the paragraph beginning at page 35, line 22 with the following new paragraph:

So ~~There has not suggested so~~ far ~~such~~ a CCD type image sensor with a ~~that its~~ CCD transfer path having ~~has~~ an oblique or curved portion in the light receptive area has not been mentioned. In particular, a CCD type transfer path having its repetitive moderate curve in the light receptive area is not known ~~at all~~ to those skilled in the art. The present embodiment, however, even as compared to the

first and second embodiments, is of the simplest and lenient construction having neither unnecessary circuits nor acute changes in direction.

Please replace the paragraph beginning at page 36, line 7 with the following new paragraph:

In a typical CCD type image sensor, ~~its~~ light receptive area has electrodes arranged from ~~its~~ one end to the other. Also in the case of the parallel CCD type sensor by Kosonocky et al. shown in Fig. 23, electrodes and gates are provided from one end to the other. On the other hand~~As against this~~, in the present embodiment, one of the four sensors, before they are incorporated as shown in Fig. 11, has no electrodes incorporated at the upper and lower sides in Fig. 10. Those wires for feeding a control voltage from the outside of the light receptive area or for reading out information to the outside of it can be incorporated arbitrarily using two-layer metal wiring, so that they can be sent along both the lower and upper sides. Therefore, by combining the four sensors as shown in Fig. 11, there is produced an elongated region with neither electrode nor wires along the center lines ~~liens~~ 83 and 84. As for pixels facing the center lines ~~centerlines~~ 83 and 84, however, the position of the charge collecting well 31 and the drains is shifted a little. In a region along the center lines ~~centerlines~~ 83 and 84, as shown in Fig. 11, there is provided a sufficiently large space

around the photodiode 30, ~~so that~~ such that ~~an extent of~~ layout changes can be done arbitrarily.

Please replace the paragraph beginning at page 37, line 4 with the following new paragraph:

If a device shown in Fig. 11 has one or two defects therein, it can be cut along the two center lines ~~centerlines~~ 83 and 84 so that a 1/4 defect-free portion ~~which is 1/4 of it~~ can be taken out. Also, thus taken out 1/4-sized defect-free portions can be butted ~~but~~ to provide a larger sensor. By providing such a cuttable/buttable layout, the yield can be drastically improved. If, for example, a device in a 1/4 -sized screen has a yield of 10%, on a double-sized screen it is 1%, and on its original size screen it is squared to 0.01%, so that only one of 10,000 devices can be used. Against this, by butting and using devices on a 1/4-sized screen, the yield with the original size is 10%.

Please replace the paragraph beginning at page 37, line 16 with the following new paragraph:

It should be noted that the image sensors shown in Figs. 24, 25A, and 25B cannot be cut and butted~~but~~. This is because the photodiode is shifted in position a little horizontally, so that a line connecting these photodiodes intersects with the centerline. On the other hand~~As against this~~, the present embodiment employs a square

layout of pixels, to be free of unevenness, thus enabling cutting and butting.

Please replace the paragraph beginning at page 37, line 23 with the following new paragraph:

Also in the case of the first and second embodiments, by changing ~~a little~~ the layout a little and the shape of the photodiode 30 along the center line, such an elongated region along the center line can be created that can be cut. For example, by decreasing the vertical length of the photodiode 30 along the center line by about 10 microns and increasing its width to provide the same area as the other photodiodes 30, there is created a 20-micron long cuttable region along the center line. Near the center line ~~centerline~~ the recording CCD transfer path 33 is rarely incorporated, thus providing a space enough for the photodiode 30 to be increased horizontally.

Please replace the paragraph beginning at page 42, line 18 with the following new paragraph:

In this fourth embodiment, the electric signal recording means is a MOS type ~~one~~.

Please replace the paragraph beginning at page 56, line 23 with the following new paragraph:

This image sensor 380 has almost the same configuration as that by Kosonocky et al. shown in Fig. 23 except that for each pixel 381 are provided two photodiodes 382a and 382b, which are connected via one charge collecting well 3a and an input gate 3b to CCD transfer paths 5 and 6. With such a configuration, even if a potential gradient is given at each of the photodiodes 382a and 382b in order to accelerate charge collection, its potential difference with the CCD transfer path 5 does not become large, thus making it possible to send ~~sent~~ a generated electric signal securely to a CCD transfer path 5 and also to use a presently available and time-proven photodiode which measure a few microns or more than 10 microns at each side.